BRITTLE MATERIAL BREAKING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for breaking of brittle material and, more specifically, to an apparatus adapted to break semiconductor wafers along scribe lines scribed on the semiconductor wafers.

2. Description of Related Art

Various equipments are requisite in a foundry during the fabrication of semiconductor wafers. In order to improve the precision and reduce the production of micro particles, apparatus for scribing and/or breaking semiconductor wafers must be maintained clean.

When breaking a semiconductor wafer according to a conventional manufacturing process, the semiconductor wafer is adhered to a thin film and then scribed with transverse and longitudinal scribe lines on the surface, and then the scribed semiconductor wafer is put on the wafer breaking apparatus, and then the breaking-cutter of the wafer breaking apparatus is lifted to break the semiconductor wafer at one of the scribe lines, and then the semiconductor wafer is shifted to a predetermined distance for enabling the breaking-cutter to break the semiconductor wafer at a second scribe line. This breaking action is repeated again and again to complete breaking of the semiconductor wafer.

During the aforesaid conventional semiconductor wafer breaking operation, the semiconductor wafer is directly carried on and maintained in

contact with the semiconductor wafer breaking apparatus. When shifting the semiconductor wafer, friction is produced between the bottom surface of the thin film at the semiconductor wafer and the top side of the semiconductor wafer breaking apparatus. This friction increases the risk of scratching damage to the semiconductor wafer and the possibility of the production of static electricity or micro particles, affecting the semiconductor wafer breaking quality. US Patent No. 5,820,006, entitled "Apparatus for scribing and/or breaking semiconductor wafers" is an example of the aforesaid prior art design.

SUMMARY OF THE INVENTION

The present invention has been accomplished under the circumstances in view. It is the main object of the present invention to provide a brittle material breaking apparatus, which prevents friction between the brittle material and the brittle material breaking apparatus, improving the breaking quality. It is another object of the present invention to provide a brittle material breaking apparatus, which has means for adjusting of the stroke of the breaking-cutter relative to the brittle material.

To achieve these and other objects of the present invention, the brittle material breaking apparatus is adapted to break a brittle material that has been scribed with a plurality of scribe lines thereon, and the apparatus comprising a base frame, a lifting mechanism, and a breaking-cutter module. The base frame comprises two parallel sliding grooves extended in vertical direction. The lifting mechanism comprises two parallel sliding rails, a transverse plate, and a driving module. The sliding rails extended in vertical

direction and adapted to slide along the sliding grooves respectively, the transverse plate affixed between the sliding rails, and the driving module adapted to drive the transverse plate and the sliding rails sliding along the sliding grooves vertically. The breaking-cutter module comprises a carrier, a driving mechanism, and a cutter assembly. The carrier mounted between the sliding rails of the lifting mechanism, the carrier comprising a central cutter slot, the driving mechanism mounted on the carrier, and the cutter assembly comprising a cutter holder, and a breaking-cutter. The cutter holder mounted on the driving mechanism and adapted to be lifted by the driving mechanism, and the breaking-cutter mounted on the cutter holder and adapted to be protruded through the central cutter slot to break one of the scribe lines of the brittle material upon upward movement of the cutter holder by the driving mechanism of the breaking-cutter module.

When wishing to break the brittle material, the apparatus is set below the brittle material, and then the lifting mechanism is controlled to lift the carrier for enabling the carrier to hold the brittle material by vacuum for breaking, and then the cutter holder is slid vertically upwards to lift the breaking-cutter through the central cutter slot of the carrier to force the cutting edge against one of the scribe lines of the brittle material. After the breaking of one of the scribe lines of the brittle material, the lifting mechanism is controlled to lower the carrier from the brittle material, and then the brittle material is shifted to a next scribe line for breaking, and then the lifting mechanism is controlled to lift the carrier again, for enabling the breaking-cutter module to break the brittle material again.

When shifting the brittle material from one scribe line to another during the aforesaid breaking-cutting operation, the lifting mechanism is controlled to lower the carrier from the brittle material at first, therefore shifting the brittle material from one scribe line to another does not cause friction between the brittle material breaking apparatus and the brittle material.

The driving mechanism of the breaking-cutter module comprises a fixed member, a movable member, and an air cylinder, the fixed member fixedly mounted on the carrier, the movable member coupled to and adapted to slide along the fixed member, and the air cylinder mounted on the movable member. The breaking-cutter module further comprises a stroke fine adjustment mechanism installed in the carrier. The stroke fine adjustment mechanism comprises a cam shaft, and a motor, the cam shaft coupled to the movable member of the driving mechanism of the breaking-cutter module, and the motor adapted to rotate the cam shaft and to further adjust vertical moving distance of the movable member relative to the fixed member so as to relatively adjust the moving distance of the cutter holder with the air cylinder relative to the brittle material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of a brittle material breaking apparatus according to the present invention.

FIG. 2 is a perspective assembly view of the brittle material breaking apparatus according to the present invention.

FIG. 3 is an applied view of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 3 is an applied view of the present invention for breaking of a brittle material **9** that has been scribed with a plurality of scribe lines **91** thereon. The brittle material **9** is adhered to a thin film carried on a rotary table **6** and maintained at a predetermined height. According to this embodiment, the brittle material **9** is a semiconductor wafer. The rotary table **6** is carried on a sliding table assembly **82**. The sliding table assembly **82** comprises a sliding rail unit **820** affixed to a flat base plate **5** and extended in longitudinal direction, and a sliding block unit **821** affixed to the bottom side of the rotary table **6** and slidably coupled to the sliding rail unit **820** for enabling the brittle material **9** and the rotary table **6** to be slid with the sliding block unit **821** along the sliding rail unit **820** so that the brittle material **9** can be broken by the apparatus of the present invention.

Referring to FIGS. 1 and 2, the brittle material breaking apparatus of the present invention is vertically spaced below the brittle material **9**, comprising a base frame **1**, a lifting mechanism **2**, and a breaking-cutter module **3**. The base frame **1** has two vertical sliding grooves **11** extended in vertical direction and arranged in parallel.

The lifting mechanism **2** comprises a driving module **21**, two parallel vertical sliding rails **22**, and a transverse plate **23**. The driving module **21** comprises a motor **211**, a cam shaft **212**, and a cam shaft linker **24**. The cam shaft linker **24** is fixedly mounted on the transverse plate **23**, having a mating slot **241** adapted to support the cam shaft **212**. The cam shaft **212** is an eccentric shaft rotated in the mating slot **241** of the cam shaft

linker **24** to drive the cam shaft linker **24** and the transverse plate **23** alternatively up and down. The transverse plate **23** is fixedly fastened between the respective lower parts of the vertical sliding rails **22**. The vertical sliding rails **22** are respectively coupled to and slidably along the vertical sliding grooves **11**. The motor **211** of the driving module **21** is fixedly mounted on the base frame **1**, and adapted to rotate the cam shaft **212** by the eccentric function, causing the vertical sliding rails **22** to be slid with the transverse plate **23** vertically along the vertical sliding grooves **11**. As shown in FIG. 1, the base frame **1** can be provided between the motor **211** and the two vertical sliding rails **22**, the motor **211** can be directly affixed to the base frame **1**, the transverse plate **23** and the two vertical sliding grooves **11** can respectively be disposed at the other side of the vertical sliding rails **22** and the other side of the base frame **1**.

The breaking-cutter module **3** comprises a driving mechanism **31**, a carrier **32**, and a cutter assembly **33**. The driving mechanism **31** further comprises a fixed member **311**, a movable member **312**, and an air cylinder **313**. The carrier **32** further comprises a carrier base **323** and a vacuum base **322**. The cutter assembly **33** further comprises a cutter holder **332**, and a breaking-cutter **331**.

The fixed member **311** of the driving mechanism **31** is mounted on the carrier base **323** of the carrier **32**. The movable member **312** of the driving mechanism **31** is slidably mounted on the fixed member **311**. The air cylinder **313** of the driving mechanism **31** is mounted on the movable member **312**. The cutter holder **332** of the cutter assembly **33** is coupled to

the air cylinder **313** of the driving mechanism **31**. The breaking-cutter **331** is mounted on the cutter holder **332**. The vacuum base **322** of the carrier **32** is mounted on the carrier base **323**. The carrier base **323** is mounted between the respective upper parts of the two vertical sliding rails **22** of the lifting mechanism **2**. The vacuum base **322** has a central cutter slot **321** on the middle.

When wishing to break the brittle material **9**, the lifting mechanism **2** is controlled to lift the carrier **32** for enabling the vacuum base **322** of the carrier **32** to hold the brittle material **9** for breaking, and then the air cylinder **313** of the driving mechanism **31** is operated to move the cutter holder **332** vertically upwards so as to lift the breaking-cutter **331** protruded through the central cutter slot **321** of the vacuum base **322** over the top side of the vacuum base **322** and to force the cutting edge of the breaking-cutter **331** against one of the scribe lines **91** of the brittle material **9**. After the aforesaid action, the lifting mechanism **2** is controlled to lower the carrier **32**, and then the rotary table **6** is slid along the sliding block unit **821** to let the next scribe line **91** of the brittle material **9** be aimed at the cutting edge of the breaking-cutter **331**, and then the lifting mechanism **2** is controlled to lift the carrier **32** again, for enabling the brittle material **9** to be hold on the vacuum base **322** of the carrier **32** again, and then the air cylinder **313** of the driving mechanism **31** is controlled to lift the breaking-cutter **331** protruded through the central cutter slot **321** of the vacuum base **322** over the top side of the vacuum base **322** again, and to force the cutting edge of the breaking-cutter **331** against the second scribe line **91** of the brittle material **9**,

and thus the second breaking-cutting action of the brittle material **9** is done.

The aforesaid breaking-cutting action is repeated again and again to complete the breaking operation of the brittle material **9**. Because the scribe lines **91** of the brittle material **9** include transverse scribe lines and longitudinal scribe lines, the rotary table **6** (see FIG. 3) can be operated to rotate the brittle material **9** through 90^0 angle, and then the aforesaid breaking-cutting action is repeated again and again to complete transverse and longitudinal breaking operation of the brittle material **9**.

When shifting the brittle material **9** from one scribe line to another during the aforesaid breaking-cutting operation, the lifting mechanism **2** is controlled to lower the carrier **32** at first, at this time the brittle material **9** is maintained at the original elevation, keeping the brittle material **9** spaced above the carrier **32** and the vacuum base **322** at the predetermined height, and therefore no direct friction is produced between the brittle material **9** and the vacuum base **322** during shifting of the brittle material **9**. Because the brittle material **9** is kept away from the vacuum base **322** during shifting, shifting the brittle material **9** from one scribe line **91** to another does not cause a scratching damage and friction loss to the brittle material **9**, or produce static electricity or particles due to friction. Therefore, the present invention improves the quality of the breaking of brittle materials. Further, the motor **211** of the aforesaid lifting mechanism **2** can be computerized to achieve precision positioning.

A displacement sensor **7** may be mounted on the base frame **1** and the transverse plate **23** of the lifting mechanism **2** to detect the sliding

distance of the lifting mechanism **2** relative to the base frame **1**. Further, two porous ceramic plates **324** are mounted on the vacuum base **322** of the carrier **32**. The porous ceramic plates **324** each have a plurality of capillaries. After putting of the brittle material **9** to be broken on the vacuum base **322**, air is drawn away from the capillaries of the porous ceramic plates **324**, thereby causing the brittle material **9** to be smoothly and positively secured to the vacuum base **322** by a vacuum force.

The breaking-cutting module **3** further comprises a stroke fine adjustment mechanism **34** mounted on the carrier base **323** of the carrier **32**. The stroke fine adjustment mechanism **34** is comprised of a motor **341** and a cam shaft **342**. The cam shaft **342** is a eccentric and coupled to the movable member **312** of the aforesaid driving mechanism **31**. The motion between the cam shaft **342** and the movable member **312** is similar to the motion between the cam shaft **212** of the aforesaid lifting mechanism **2** and the cam shaft linker **24**. The motor **341** is fixedly mounted on the carrier base **323** and controlled to rotate the cam shaft **342**, adjusting the vertically slidably distance of the movable member **312** on the fixed member **311**, i.e., rotating the cam shaft **342** causes a movement of the movable member **312** of the driving mechanism **31** relative to the fixed member **311**, and the air cylinder **313** as well as the cutter holder **332** are followed. At this time, the stroke (moving distance) of the breaking-cutter **331** of the cutter assembly **33** relative to the brittle material **9** is relatively adjusted.

Although the present invention has been explained in relation to its preferred embodiment, it is to be understood that many other possible

modifications and variations can be made without departing from the spirit and scope of the invention as hereinafter claimed.